High Performance Thermal Imaging Using Quantum Well Infrared Photodetector Arrays

HARALD SCHNEIDER, Forschungszentrum Rossendorf, Institute of Ion-Beam Physics and Materials Research

Quantum well infrared photodetector (QWIP) technology has opened up new opportunities to realize focal plane arrays (FPA) for high-performance thermal imaging [1]. High thermal and spatial resolution, low 1/f noise, low fixed-pattern noise, and high pixel operability makes QWIP FPAs appropriate for many applications. Due to their narrow absorption bands with relative spectral widths $\Delta \lambda / \lambda$ of the order of 10%, QWIPs are particularly suitable for thermal imaging applications involving several atmospheric transmission bands or several colors within the same band. For dual-band/dual-color FPAs, QWIP technology has the unique property that the active region for the long-wavelength band is transparent for the short-wavelength band. In this talk, I will report on typical QWIP structures optimized for thermal imaging applications and on the performance of some state-of-the-art QWIP cameras which were jointly realized by the Fraunhofer-Institute for Applied Solid State Physics (Freiburg, Germany) and AIM Infrarot-Module GmbH (Heilbronn, Germany). Besides imagers for the 8 – 12 $\mu$m long-wavelength infrared (LWIR) and 3 – 5 $\mu$m mid-wavelength infrared (MWIR) regimes, these include a LWIR/MWIR dual-band QWIP FPA with 384x288 pixels which, at 6.8 ms integration time, exhibits a noise-equivalent temperature difference as low as 20.6 mK in the LWIR and 26.7 mK in the MWIR spectral bands. A specially designed diffraction grating is used for optical coupling of both spectral regimes. The array, which is based on a photoconductive QWIP for the MWIR and a photovoltaic “low-noise” QWIP for the LWIR, allows for synchronous and pixel-registered image acquisition in both bands. This functionality yields several advantages, including better distinction between target and background clutter, operation in a much wider range of ambient conditions, and the ability of remote absolute temperature measurement.